

food security. The same small pack approach is also being used to make seeds more affordable and widely available.

Working with FAO, local agricultural centers, a network of international donors and partners, including the West and Central African Council for

Agricultural Research and Development and USAID, ICRISAT hopes to increase the number of farmers using microdosing and the warrantage system from 25,000 to 500,000 in the next few years. This will be an important step to increase food production, and will go a long way in alleviating food scarcity and hunger in the semi-arid tropical regions.



A microdosed crop (left) versus one without the fertilizer boost.

# Fertilizer Microdosing

## Boosting Production in Unproductive Lands



## About ICRISAT



Science with a human face

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is a non-profit, non-political organization that does innovative agricultural research and capacity building for sustainable development with a wide array of partners across the globe. ICRISAT's mission is to help empower 644 million poor people to overcome hunger, poverty and a degraded environment in the dry tropics through better agriculture. ICRISAT belongs to the Alliance of Centers of the Consultative Group on International Agricultural Research (CGIAR).

### Company Information

**ICRISAT-Patancheru (Headquarters)**  
Patancheru 502 324  
Andhra Pradesh, India  
Tel +91 40 30713071  
Fax +91 40 30713074  
icrisat@cgiar.org

**ICRISAT-Liaison Office**  
CG Centers Block  
NASC Complex  
Dev Prakash Shastri Marg  
New Delhi 110 012, India  
Tel +91 11 32472306 to 08  
Fax +91 11 25841294

**ICRISAT-Nairobi (Regional hub ESA)**  
PO Box 39063, Nairobi, Kenya  
Tel +254 20 7224550  
Fax +254 20 7224001  
icrisat-nairobi@cgiar.org

**ICRISAT-Niamey (Regional hub WCA)**  
BP 12404, Niamey, Niger (Via Paris)  
Tel +227 20722529, 20722725  
Fax +227 20734329  
icrisatnsc@cgiar.org

**ICRISAT-Bamako**  
BP 320  
Bamako, Mali  
Tel +223 20 223375  
Fax +223 20 228683  
icrisat-w-mali@cgiar.org

**ICRISAT-Bulawayo**  
Matopos Research Station  
PO Box 776,  
Bulawayo, Zimbabwe  
Tel +263 83 8311 to 15  
Fax +263 83 8253/8307  
icrisatzw@cgiar.org

**ICRISAT-Lilongwe**  
Chitedze Agricultural Research Station  
PO Box 1096  
Lilongwe, Malawi  
Tel +265 1 707297/071/067/057  
Fax +265 1 707298  
icrisat-malawi@cgiar.org

**ICRISAT-Maputo**  
c/o IIAM, Av. das FPLM No 2698  
Caixa Postal 1906  
Maputo, Mozambique  
Tel +258 21 461657  
Fax +258 21 461581  
icrisatmoz@panintra.com

[www.icrisat.org](http://www.icrisat.org)

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INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS  
Science with a human face



Research carried out at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) indicate that land degradation affects more than half of Africa, leading to loss of an estimated US\$42 billion in income and 5 million hectares of productive land each year. The majority of farmlands produce poor yields due to poor farming techniques, nutrient deficiency and lack of water.

Land degradation is particularly acute in sub-Saharan African regions where long-term overuse of soil and low, unpredictable rainfall are prime reasons for poor food production. The farmers are so poor that they take everything they can out of the soil and are not willing to invest in fertilizer because the growing season is very risky. The failure to replenish the soil fuels an unrelenting, vicious cycle. Unless nutrients are replaced, soils are depleted and yields and crop quality decline, leading to widespread hunger and under nutrition.

Unable to feed their families or afford to buy food, farmers abandon unproductive land to clear forests and plow new land, and the cycle repeats. Clearing new lands for farming is blamed for an estimated 70% of the deforestation in Africa.

To address the problem of soil fertility, which is a greater constraint to food production than drought across much of sub-Saharan Africa, scientists at ICRISAT have developed a precision-farming technique called 'Microdosing'. Microdosing involves the application of small, affordable quantities of fertilizer with the seed at planting time or as top dressing 3 to 4 weeks after emergence. This enhances fertilizer use efficiency instead of spreading fertilizer over the field, and improves productivity. Rather than asking how a farmer can maximize her/his yields or profits, microdosing asks how a farmer can maximize the returns to a small initial investment – that might grow over time, turning deficits into surpluses.

### The Technique

Farmers who use microdosing apply 6 gram doses of fertilizer—about a full bottle cap or a three-finger pinch -- in the hole where the seed is placed (at the time of planting). That translates to about 67 pounds of fertilizer for every 2.5 acres.

This technique uses only about one-tenth of the amount typically used on wheat, and one-twentieth of the amount used on corn in the USA. Yet the African crops are so starved of nutrients



*A small amount of fertilizer is added to the planting hole at the time of sowing.*

such as phosphorous, potassium and nitrogen that even this micro amount often doubles crop yields.

Techniques and type of fertilizer vary depending on soil and climate conditions. Farmers in ICRISAT's project countries have developed innovative techniques to apply microdoses of the appropriate fertilizer.

While farmers in southern Africa use fertilizer measured out in an empty soft drink or beer bottle cap, in western Africa the farmers measure fertilizer with a three-finger pinch and apply it in the same hole in which seed is sown.

Where soil is hard, farmers dig small holes before the rain starts, then fill it with manure, if available. When rains begin, they put fertilizer and seeds in the hole and the soil provides a moist environment, encouraging root growth, and the water is captured instead of running off the hard-crust soil.

By correcting soil deficiencies for essential nutrients with tiny doses, root systems develop and capture more water, increasing yields.

### The Impact

The fertilizer microdosing technique has the potential to end widespread hunger in drought prone areas of Africa.

Microdosing has reintroduced fertilizer use in Zimbabwe, Mozambique and South Africa in the southern part of the African continent. In western Africa, currently, some 25,000 smallholder farmers in Mali, Burkina Faso, and Niger have learned the technique and experienced increases in sorghum

and millet yields of 44 to 120%, along with an increase in their family incomes of 50 to 130%.

Although the results have shown consistent yield increases, farmers have reported that microdosing is time consuming, laborious and difficult to ensure each plant gets the right dose of fertilizer. In an attempt to address these issues, researchers are looking at packaging the correct dose of fertilizer as a tablet that aids in application, and this is proving popular. ICRISAT is also exploring the use of seed coating as another option of further reducing the quantity of fertilizer to be used as well as the labor constraint.

Several factors have been identified as major constraints to the widespread adoption of microdose technology. These include access to fertilizer; access to credit; insufficient flows of information and training to farmers; and inappropriate policies. Experiences from both west and southern Africa have shown that adoption of microdose technology requires supportive and complementary institutional innovation as well as input and output market linkages.

### The Warrantage system

ICRISAT along with its collaborating partners are testing two market development strategies to address constraints.

Poor farmers have a hard time getting their grain to market and storing it. Thus, they sell to middlemen right after harvest when supplies are high and the price is low because they need cash at the end of the season.

In West Africa, the 'Warrantage' or inventory credit strategy aims to resolve the farmers' capital constraint. Farmers place part of their harvest in a local storehouse in return for inventory credit with which to meet pressing post-harvest expenses and engage in dry season income generating activities such as sheep fattening, vegetable growing using small scale irrigation (ie, drip irrigation), groundnut oil extraction and small trading, among several others. The stored grain may then be sold later in the year at much higher prices and the farmers can make a profit.

This way the farmer, and not the middleman, gets the profit. The cooperative approach trains farmers to work together to protect stored grains from insects and also helps them to buy fertilizer in bulk, then repackage it in smaller, more affordable, units. Hundreds of farmer organizations in the region



*Farmers placing their harvest in storage in return for credit.*

now use this warrantage system, which links them directly to markets.

### Fertilizer in small packets

In eastern and southern Africa, ICRISAT is working with private fertilizer companies to identify appropriate fertilizer types and promote the sale of small packs suited to the resource constraints and risk preferences of small-scale farmers. Many farmers simply cannot afford the 50 kg bags of fertilizer commonly sold. But they are able to afford a 5 kg or 10 kg bag. Companies initially resisted because they wanted to sell more fertilizer, not less, but ICRISAT has successfully argued that to sell small quantities in small packs is better than selling nothing.

Scientists estimate that over time the unit costs will decline and households will boost the fertilizer market by investing more to produce a marketable crop surplus, though many will simply improve their



*Measuring out small packs of fertilizer.*